

March 2002



# **ERRATA**

**to**

## **BMP Retrofit Pilot Program**

## **OPERATION MAINTENANCE AND MONITORING PLAN**

Please make the following changes as summarized below and included in attached pages.

	<b>Affected Pages</b>	<b>Change to be made</b>
1	District 7 and District 11 Volume I Section 2.0 Operation and Maintenance	Insert letter <i>RE: Wildlife Issues Related to BMP O&amp;M</i>
2	District 7 and District 11 Volume I Section 5.1.2 Criteria for Mobilization	Insert letter <i>RE: Mobilization and Analysis Criteria for the Caltrans BMP Retrofit Pilot Program During the 99/00 Wet Season</i>
3	District 7 and District 11 Volume I Section 5.2.3 Sediment Characterization	Insert <i>In-Situ Sediment Sampling and Characterization in Caltrans BMPs</i>
4	District 7 Volume I Appendix F Estimating Pollutant Loadings and BMP Efficiency	Insert <i>CRITERIA FOR DETERMINATION OF ADDITIONAL DRAIN INLET INSERT MONITORING REQUIREMENTS AND USE OF 1998-1999 MONITORING RESULTS</i>
5	District 7 and District 11 Volume II Appendix C – Drain Inlet Inserts Section 5.7.1 Sediment Collection	Insert Plan <i>Austin Sand Filter Sampling and Analysis Plan</i>
6	District 7 and District 11 Volume II Appendix E – Biofiltration Swales Section 5.9 Hydraulic Residence Time Evaluation	Insert <i>ESTIMATING SWALE HYDRAULIC RESIDENCE TIME (HRT) AT DESIGN FLOW RATE</i>
7	District 7 Volume II Appendix H – Continuous Deflective Separators	Insert Letter <i>BMP Operation, Maintenance and Monitoring Plan - CDS</i>

## Item 1

FM: Christopher W. May, NRDC Technical Advisor  
TO: Brian Currier, CALTRANS BMP Pilot Study Coordinator  
RE: Wildlife Issues Related to BMP O&M

On behalf of the Natural Resources Defense Council (NRDC), Santa Monica Baykeeper, and San Diego Bay-Keeper, I would like to address the issue of gopher damage to pilot BMP facilities. Our policy with regard to the operation and maintenance (O&M) of pilot study BMPs is that currently accepted, “state of the art” procedures should be utilized. In Addition, we have also made it clear that the level of effort required to perform “standard” O&M activities should not be extraordinary. While this may be well understood as applied to conventional O&M practices such as monitoring and routine repairs of structural BMP components, we also feel that this approach applies equally in any interactions with native flora and fauna. In any case, operation and maintenance of BMPs should not be driven too strongly by efforts to eliminate “nuisance” wildlife, sensitive species, or invasive/exotic vegetation. In short, BMPs should not be maintained based on a goal of preventing species utilization.

As an example, weeding of BMPs should be conducted only if the vegetation present is having a detrimental effect on BMP performance (such as in a bio-filtration unit) or because the plants have been classified as noxious or invasive, and as such have been targeted for removal by regional agencies. Using herbicide to prevent weed growth would not be appropriate. In the case of the gophers that have been damaging several of the vegetated BMPs, we feel that periodic repair to the BMPs, per the Maintenance Indicator Document (MID) is adequate and appropriate. It is our position, that the efforts that have taken place thus far (e.g. trapping) in order to eliminate all gopher activity in the BMPs have been ineffective and are not necessary to ensure proper BMP function. We are of the opinion that trapping should be discontinued. We also do not approve of the use of pepper spray or other wildlife inhibitors at BMP sites. Routine MID activities such as filling gopher holes, compacting gopher mounds, and reseeded bare patches within the BMPs should be adequate to ensure proper BMP operation. In special cases (i.e. the Cerritos bioswale) more extensive repairs may be necessary to maintain the structural integrity of the BMP, but this appears to be the exception rather than the rule.

The presence of relatively lush vegetation, uncompacted soils, and irrigation water in the bio-filtration BMPs has created desirable habitat for gophers and other native fauna, such as reptiles and some insects such as native butterfly species. Based on our basic knowledge of gopher ecology, it is highly unlikely that we could eliminate all gophers from these BMP sites using any known methods, nor is it, in our opinion, necessary to the proper operation of the BMPs. The wetland vegetation found in the constructed wet-basin and some of the other BMPs is another example of the relatively good habitat that can become established within CALTRANS right-of-ways (ROWs) due to the construction and operation of stormwater BMPs. As we have stated on several occasions, this is something that must be accepted and should be viewed as a benefit rather than a liability. By the same token, efforts to actively preclude gophers or any other wildlife from BMP sites is neither feasible nor desirable from our perspective, and should not be pursued. It is obvious that these BMP sites may offer suitable habitat for a variety of native flora and fauna. In the long-term, a reasonable O&M strategy would be to “coexist” rather than “conflict” with nature. Whether the species of concern is considered a “pest” like gophers or “threatened/endangered” (gnatcatchers, burrowing owls, etc.) should not be the deciding factor. CALTRANS should work closely with state and federal wildlife agencies to inform them of

BMP operations and potential habitat related issues. In the event that a conflict develops the goal should be to protect sensitive species while maintaining BMP function.

Christopher W. May  
NRDC Technical Advisor

## Item 2

**CALTRANS - UCD - CSUS STORM WATER QUALITY PROJECT**  
**ENVIRONMENTAL PROGRAM - MS27**

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April 17, 2000

Richard Horner  
230 N. W. 55<sup>th</sup> Street  
Seattle, WA 98107

RE: Mobilization and Analysis Criteria for the Caltrans BMP Retrofit Pilot Program  
During the 99/00 Wet Season

Dear Rich,

This letter is intended to clarify the issues surrounding the mobilization and analysis criteria for monitoring the BMP Retrofit Pilot Studies conducted in the Los Angeles and San Diego areas. As agreed upon between the Plaintiffs and Caltrans, the revised criteria has been effective since April 06, 2000 and is as follows:

1. For mobilization concerning antecedent dry period for the remainder of the 99/00 wet season: If the first event of two consecutive storms (< 48 hours) is not captured, and the second event is forecast for at least as large as the first event, with the first event not greater than 0.25 inches, mobilization will occur for the second event. Otherwise, follow current antecedent dry period criteria.
2. For all BMP monitoring where paired samples are taken (this season and future events): If a sample is between 50%-75% capture, and has 20 or more aliquots, then analyze data. If a sample is below 12 aliquots, percent capture is greater than 85%, and sample volume captured is sufficient for full analysis, then analyze data.
3. Data not meeting above criteria will not be considered for analysis. Data meeting the above criteria, but not meeting the OMM criteria, will be flagged as outside the normal criteria, and acceptance of the flagged data for the BMP efficiency analysis will be made jointly by experts from Plaintiffs and Caltrans.
4. On an annual basis, Caltrans will chase storms, weather permitting, until we reach the required storms per year that meet the OMM goal of 75% capture and 12 aliquots (samples) per event, as well as the Scoping Study storm event separation minimum of 48 hours.

If you have any questions regarding these criteria, please do not hesitate to call me at (916) 653-8809. Thank you.

Sincerely,

Brian Currier  
Water Quality Engineer

Cc: Steve Borroum, Caltrans  
Pete Van Riper, Caltrans  
Bob Wu, Caltrans  
Scott Taylor, RBF  
...



### **Item 3**

## **In-Situ Sediment Sampling and Characterization in Caltrans BMPs**

### **Introduction**

As part of the Caltrans BMP Retrofit Pilot Program Maintenance Indicator Document, sediment in Extended Detention Basins will be sampled annually (June 1 each year). Sediment will be removed if any parameter concentration exceeds 50% of the Title 22 TTLC. Or, if the parameter concentration is less than 50% of the TTLC, but falls between 10X the STLC and the WET results exceed 50% of the STLC value.

### **Objectives**

It is the consultants' understanding that the objective of this sediment sampling and characterization is two-fold:

- 1) To remove sediment in BMPs before it can be labeled as legally toxic. Toxicity is based on contaminant concentration not accumulated mass; therefore, allowing sediments to build-up will not necessarily increase its toxicity.
- 2) To provide data on the rate of contaminant accumulation in BMPs.

If it is Caltrans' main intention to remove potentially hazardous sediment before it becomes legally hazardous so as to save money by lowering overall maintenance costs, then annual sediment testing should occur at all BMP sites that accumulate deposited sediment. Therefore, sediment sampling and characterization would occur at wet basins, media filter pre-sedimentation chambers, biofiltration swales and strips, infiltration basins, and any other BMPs in District 7 that will accumulate sediment.

The understated objective of removing sediment before it becomes toxic is to save money. However, annual sediment characterization may be more costly than removing deposited sediments once they impede BMP performance (see Maintenance Indicator Document for volumetric thresholds per BMP). Annual sediment sampling will require a minimum of 16 man hours per site (see protocol below). Moreover, the laboratory costs associated with testing this sediment are expensive (see Table 1).

**Table 1 Cost per Sediment Sample**

<b>Analyses</b>	<b>Unit Cost</b>
TRPH	\$ 50.00
VOC	\$150.00
Total Metals	\$150.00
WET Extraction	\$68.00
TCLP Metals Extraction	\$68.00
Extract Analyses (WET) <sup>1</sup>	\$150.00 <sup>2</sup>
Extract Analyses (TCLP) <sup>1</sup>	\$150.00 <sup>2</sup>

<sup>1</sup> – Assumes sample will be analyzed for all metals.

<sup>2</sup> - Assumes sample will have to be analyzed for this method

On the other hand, if it is Caltrans' main intention to acquire information on contaminant accumulation, annual sediment testing will only provide two data points on contamination rates per BMP site over a two-year period. These two data points provide the absolute minimum for the determination of a contaminant accumulation rate. The scientific and statistical validity of these two data points is extremely questionable. In addition, most of the BMPs in District 11 and 7 have not accumulated nearly enough sediment to be accurately tested. Therefore, the proposed protocol has a volume requirement for sediment sampling, which will negate sampling at the majority of BMP sites. The proposed protocol is given below.

### **Sampling Protocol**

The current sampling protocol in the OMM Volume II is designed to sample sediment once it is removed and stockpiled and does not provide adequate procedures to test sediment within the BMPs. Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. The EPA Method SW-846 has been changed to provide a sampling analysis plan that thoroughly characterizes the contamination levels of deposited sediments within a BMP (*Statistical Methods for Environmental Pollution Monitoring*, 1987). The following protocol will be adhered to when sampling deposited sediments within BMPs.

Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G in the Field Guidance Notebooks, OMM Volume II). The standard list (Table 2) is based on highway contaminants that have the potential to exceed hazardous waste criteria and are required by hazardous waste removal and transport companies. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

Consultants will first determine the area of deposited sediments in the BMP by superimposing a square meter grid over the floor of the BMP basin or chamber. Using a x-y origin, the floor of the BMP will be separated into square meter cells and the sampling area will then be determined. A square meter cell will be included into the sample area if more than 50% of that square meter contains deposited sediments and if the average depth of the deposited sediment measures at least 1 inch. Depth indicators from sediment probes and visual signs, such as discoloration (i.e., black or darkened sediment) or grain size differences, will be used to determine sediment deposition.

If the BMP has a sufficient volume of deposited sediments (at least 1 square meter with 50% coverage with at least an inch of deposition), then at least 30% of its square meter cells will be randomly selected and sampled.. For example, for a deposited area 12 square meters, four cells will be randomly selected and sampled .

First, discrete samples for volatiles will be taken from a random point within each square meter cell. These samples will be collected using Sampling Method 5035. Next, deposited sediment within each selected square meter cell will be collected with a teflon or stainless steel scoop. for Total Metals. An equal volume of sediment from each square meter cell will be collected and composited for Total Metals. This equal volume must be adequate enough to sample the entire depth of deposited sediments within each square meter cell. Equal volumes from each square meter cell will be composited to provide an overall contaminant characterization for Total Metals within the BMP.

The following steps will be used to collect sediment samples:

1. Don personal protective equipment.
2. Locate the randomly selected square meter cell on the x-y coordinate.
3. Collect a volatile sample using an EnCore or equivalent sampler from a random sampling point within the square meter cell. Place the volatile sample into the container provided with the sampler.. This sample will be labeled as and analyzed for TRPH and VOC.
4. For the Total Metal samples, use a stainless steel or teflon scoop to collect a pre-determined volume of sediment from a random sampling point within the square meter cell. This pre-determined volume must be adequate enough to allow the entire depth of deposited sediment to be sampled. Place the Total Metals sediment sample into a disposable compositing bowl.
5. Repeat this process until all of the square meter cells have been sampled for volatiles and Total Metal.
6. The Total Metal samples will be homogenize in the disposable compositing bowl using a disposable spatula or spoon. Fill a pre-labeled 8-ounce glass jar with this portion of the sample and close the container with the cap.
7. Wipe the outside of each sample container with a clean paper towel.
8. Record the sampler's initials, date, and time on the pre-labeled sample jar.
9. Place the sample containers in individual zip-top plastic bags and seal the bags.
10. Immediately pack the samples into a chilled cooler. Total metals samples do not need to be cooled
11. Record the required information on the Chain-of-Custody Form.
12. Document the sampling event, recording information in the designated field logbook.

Unless observations indicate additional testing, sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 2 using Title 22 criteria (State of California, 1985). This table also lists the required detection limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the stormwater samples.

**Table 2**  
**Sediment Matrix**  
**Analytical Parameters, Methodologies, Detection Limits, Holding Times,**  
**Container Volumes and Types, and Preservation**

Parameter	Method	Units	Project Detection Limit	Maximum Holding Time	Preservation	Container Size/Type <sup>1</sup>
Total Extractable Petroleum Hydrocarbons (TEPH)	8015M	mg/kg	10	14 days	4 °C	8 oz glass jar
Total Volatile Petroleum Hydrocarbons (TVPH)	8015M	mg/kg	1	14 days	4 °C	8 oz glass jar
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	8020	ug/kg	5-15	14 days	4 °C	8 oz glass jar
Total Metals	6020	mg/kg	0.5 2.5 0.3 2.0	180 days	4 °C	8 oz glass jar
Chromium						
Copper						
Lead						
Zinc						
Waste Extraction Test (WET) Metals:	STLC	mg/L	0.05 0.12 0.5 0.1	180 days	4 °C	NA <sup>5</sup>
Chromium						
Copper						
Lead						
Zinc						
Toxicity Characteristic Leaching Procedure (TCLP) Metals:	TCLP 1311	mg/L	0.5 0.5 0.5 0.5	180 days	4 °C	NA <sup>5</sup>
Chromium						
Copper						
Lead						
Zinc						

1. Each sample will be collected in two 8 oz glass jars or two 500 mL plastic jars (HDPE) as appropriate for the sample type.
2. Metals commonly found in sediment collected from Caltrans drain inlets. If other California Assessment Manual (CAM) metals (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn) are suspect then samples will be analyzed for them.
3. Any sample for total metals (Total Threshold Limit Concentration [TTLC]) which exceeds ten times the Soluble Threshold Limit Concentration (STLC) will be analyzed by the WET.
4. If any of the WET-soluble are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP.
5. Samples undergoing WET and TCLP extraction will be aliquoted from the Total Metals container.

## Item 4

## ATTACHMENT A

### CRITERIA FOR DETERMINATION OF ADDITIONAL DRAIN INLET INSERT MONITORING REQUIREMENTS AND USE OF 1998-1999 MONITORING RESULTS

#### NOTES

1. Every attempt shall be made to monitor consecutive storms meeting the deployment criteria.
2. Define a “case” as a combination of a site (Foothill, Las Flores, or Rosemead) and an insert (Stream Guard or Fossil Filter ).
3. Refer to the Explanatory Notes following the Acceptance Criterion.

#### MONITORING COVERAGE CRITERIA

1. Before application of the subsequent criteria, each case must be represented by at least eight successfully monitored rainfall events over two wet seasons (1998-1999 and 1999-2000). For Fossil Filter cases only those events successfully monitored after installation of stainless steel filters will count toward the eight events. Therefore, the minimum numbers of events in 1999-2000 are:

	<u>Fossil Filter</u>	<u>Stream Guard</u>
Foothill	5	4
Las Flores	6	3
Rosemead	5	5

2. In each wet season each case must have median percent storm capture  $\geq 60\%$ , and no more than one case can have median percent storm capture  $< 70\%$ .
3. In each wet season the median percent storm capture for all cases must be  $\geq 80\%$ , and the mean percent storm capture for all cases must be  $\geq 75\%$ .

#### CALCULATIONS

1. For each of the five pollutants measured in the inlet media (total solids, total Cu, total Pb, total Zn, and TRPH), calculate percent efficiency representing the time interval since the last time the insert medium was changed, using the equation:

$$\text{Efficiency (\%)} = ([\text{Estimated influent pollutant mass} - \text{Effluent pollutant mass}] / \text{Estimated influent pollutant mass}) \times 100$$

2. Estimate the influent pollutant mass for the time interval according to:

Estimated influent pollutant mass = Insert medium pollutant mass + Total effluent pollutant mass for the time interval

3. Calculate total effluent pollutant mass in two ways, and compute efficiency with each method for comparison:

- I. Storm-by-storm method:

- A. Estimate the effluent mass for each storm event in the time interval according to:

Estimated event effluent pollutant mass = (Effluent EMC) x (Event runoff volume)

Where EMC = Event mean concentration

- B. For storm events that were successfully monitored, use the measured data.

C. For any storm event during the time interval that met the deployment criteria but was not successfully monitored, estimate the EMC for that event as the mean of all EMCs measured for that case in all storm events during the time interval. How the mean EMC is determined depends on whether the data tend more to be normally or log-normally distributed. If the concentrations tend more to be normally distributed, use the arithmetic mean of the effluent EMCs. If they tend more to be log-normally distributed, calculate the mean effluent EMC by log-transforming individual storm EMCs, averaging, and then transforming back.

- D. Add the effluent pollutant masses from all storm events in the time interval.

- II. Aggregated storm method:

- A. Estimate the total effluent mass for all storm events in the time interval according to:

Estimated total effluent pollutant mass = (Mean EMC) x (Total runoff volume)

B. How the mean EMC is determined depends on whether the data tend more to be normally or log-normally distributed. If the concentrations tend more to be normally distributed, use the arithmetic mean of the effluent EMCs measured for that case in all storm events during the time interval. If they tend more to be log-normally distributed, calculate the mean effluent EMC by log-transforming individual storm EMCs, averaging, and then transforming back.



4. Compute mean efficiencies for each pollutant and each wet season by averaging results computed according to steps 1-3 for all time intervals in that wet season.

## ACCEPTANCE CRITERION

The monitoring events from 1998-1999 (after installation of stainless steel filters for Fossil Filter cases) can count toward the minimum eight events for each case, and their results can be used to express treatment efficiencies, if the mean percent efficiencies for 1998-1999 are not more than 20% lower than the 1999-2000 mean percent efficiencies (computed as  $0.2 \times 1999\text{-}2000\%$  efficiency) for at least four of the five pollutants measured.

For any case failing to meet this criterion, the minimum eight storm events shall be monitored in 1999-2000; if the minimum is not reached in 1999-2000, monitoring shall continue in the 2000-2001 wet season until the minimum number is reached. The 1998-1999 results shall not be used to express treatment efficiencies for cases failing to meet the criterion.

## EXPLANATORY NOTES

### General

The effect of gaps at some installations, which allow runoff to bypass the insert and not receive treatment, is to reduce the calculated efficiency of pollutant capture. The effect of contamination of the effluent sampling chamber by untreated runoff flowing directly into the chamber from the pavement is also to reduce calculated efficiency of pollutant capture. If the two faults occur together, they accentuate the tendency to reduce calculated efficiency. The degree to which calculated efficiency is reduced depends on the relative magnitudes of the various numbers that go into the efficiency computation. Both faults occurred during the 1998-1999 monitoring. The criterion for accepting and using the 1998-1999 results involves comparison of the calculated efficiencies for the various contaminants measured then and in 1999-2000, after correction of the problems, and determining if the 1998-1999 estimated efficiencies are generally lower than the 1999-2000 values by a set margin (criterion for rejection of 1998-1999 results).

### Notes for Monitoring Coverage Criteria

1. The minimum number of 1999-2000 events for each case is the difference between the minimum total number (eight) and the number of successfully monitored 1998-1999 events (after installation of stainless steel filters for Fossil Filter cases).
2. The 1998-1999 data comply with Criteria 2 and 3. Their purpose is to ensure at least comparable coverage in 1999-2000.

### Notes for Calculations

1. Treatment efficiencies shall be computed each time the media are removed according to manufacturers' instructions and analyzed for pollutant mass.
2. For Fossil Filter inserts, the replacement criterion, according to the manufacturer's instructions, shall be when the granules are dark gray or darker, or the medium is clogged with sediment. For Stream Guard inserts, the replacement criterion, according to the manufacturer's instructions, shall be when the sediment depth is greater than 6 inches, or when evidence of an oily sheen is observed in the insert or downstream of the drain inlet. Also, both types of drain inlet media shall be removed annually at the end of the wet season (April 30) and analyzed. The media shall be replaced before October 1 of each year.
3. More or less than the 1999-2000 minimum number of successfully monitored rainfall events for a case may occur before the medium is removed. If removal is before the minimum has been reached, monitoring shall continue until the next occasion on which the medium is to be removed according to the manufacturer's instructions.

## Item 5

## Austin Sand Filter Sampling and Analysis Plan

Surface sediment and filter bed material will be sampled from within Sand Filters requiring maintenance. Nine cores will be collected from locations on an equilateral grid (superimposed over the sand filter) to quantify sediment accumulation and quality data. The cores will be driven 15 inches below the sediment surface and recovered. A log will be used to document depth of penetration and recovery, location, and lithological characteristics. Each core will then be subdivided into four sections as follows:

- Section 1: Sediment layer (i.e., crust)
- Section 2: Beneath crust layer to 5 inches
- Section 3: 5 inches beneath crust layer to 10 inches
- Section 4: 10 inches beneath crust layer to 15 inches

Homogenize each Section of the nine cores to create four samples (e.g., homogenize the crust layer from each of the nine cores). Deposit each of the four samples into wide-mouth glass amber jars and submit with chain-of-custody form to the laboratory. Each sample will be analyzed for the following parameters:

Parameter	Analytical Method	Section 1	Section 2	Section 3	Section 4
Title 22 Metals (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, Zn)	EPA 6020/7471				
WET Metals	STLC Extraction	(1)			
TCLP Metals	TCLP 1311	(2)			
Total Recoverable Petroleum Hydrocarbon (TRPH)	EPA 1664A				
Volatile Organics	EPA 8260B				
Grain Size Distribution	Sieve Analysis - Caltrans Test 202				
	Hydrometer Test – Test 203				
Organic Matter Content	ASTM D2974				

- (1) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.
- (2) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, then analysis of the waste by TCLP may be required.

## Item 6

## ESTIMATING SWALE HYDRAULIC RESIDENCE TIME (HRT) AT DESIGN FLOW RATE

Subscript notation: <sub>m</sub>—Measured during HRT test; <sub>c</sub>—Calculated using measured quantities; <sub>d</sub>—Under swale design conditions or calculated using design conditions; <sub>a</sub>—Assumed value.

1. Calculate flow velocity (ft/s) during test:  $V_c = Q_m/A_c$

$Q_m$  = Measured flow rate (cfs) [Averaged over one or more periods if fluctuating.]

$A_c$  = Flow cross-sectional area (ft<sup>2</sup>) [In shallow flow can be approximated as a rectangle, regardless of swale shape, and computed as  $A_c = d_m * w_m$ . In deeper flow use area equation for appropriate shape, e.g.,  $A_c = b * d_m + Z * d_m^2$  for trapezoid.]

$d_m$  = Measured flow depth (ft)

$w_m$  = Measured water surface width (ft)

$b$  = Swale bed width (ft)

$Z$  = Side slope as horizontal:vertical ratio

2. Calculate Manning's n under test conditions:  $n_c = (1.49/V_c) * R_c^{0.67} * s^{0.5}$

$R_c$  = Flow hydraulic radius (ft) [In shallow flow can be approximated as a rectangle, regardless of swale shape, and computed as  $R_c = (w_m * d_m)/(w_m + 2 * d_m)$ . In deeper flow use area equation for appropriate shape, e.g.,  $R_c = (b * d_m + Z * d_m^2)/(b + 2 * d_m * (Z^2 + 1)^{0.5})$  for trapezoid.]

$s$  = Longitudinal slope (ft/ft) [Carefully measured with surveying equipment.]

3. Calculate a value of HRT ( $HRT_c$ , min.) under test conditions to compare with value measured by timed dye travel ( $HRT_m$ , min.):  $HRT_c = L/(V_c * 60)$

$L$  = Swale length (ft)

4. For all swales tested, plot  $HRT_m$  versus  $HRT_c$  to check agreement based on how close points fall to a 1:1 line or a linear regression calculation. If agreement is relatively good, the scaling calculation below gives a reasonable estimate of HRT under design flow conditions.
5. Determine design flow rate ( $Q_d$ ), which should be in the record for swales designed for runoff treatment. If unavailable,  $Q_d$  can be estimated from Manning's Equation using a known or assumed design flow depth and Manning's n:  $Q_d = (1.49/n_a) * A_d * R_d^{0.67} * s^{0.5}$

$A_d$  and  $R_d$  are computed with the appropriate equation, assuming a rectangular cross section in shallow flow or the swale shape in deeper flow, known or assumed design flow depth, and water surface width at that depth.

$n_a$  can be taken as 0.2-0.3, with some recent work showing the choice not to be critical for design, but 0.3 to be the slightly superior value.

6. Set up Manning's Equation to solve for the flow depth estimated to exist at design flow conditions ( $d_d$ , ft). In shallow flow, assuming a rectangular cross section, the equation would be:  $Q_d = (1.49/n_c) * (w_m * d_d) [ (w_m * d_d) / (w_m + 2 * d_d) ]^{0.67} * s^{0.5}$

Use values of  $Q_d$ ,  $n_c$ ,  $w_m$ , and  $s$  from previous steps and solve iteratively for  $d_d$ . This equation assumes that water surface width does not vary much with small changes in flow depth. In deeper flows substitute the expressions for  $A$  and  $R$  appropriate to the swale shape.

7. Calculate flow cross-sectional area expected at design flow rate: In shallow flow,  $A_d = d_d * w_m$  (In deeper flow use equation appropriate for swale shape.)
8. Calculate flow velocity expected at design flow rate:  $V_d = Q_d / A_d$
9. Calculate ratio of measured to design velocity:  $V_m / V_d$
10. Use the ratio from step 9 as a scaling factor to estimate HRT at design flow:  $HRT_d = HRT_m * (V_m / V_d)$



## Item 7



August 31, 2000

Mr. Brian Currier  
Water Quality Engineer  
CALTRANS  
1120 N. Street, Room 4301 (MS 27)  
Sacramento, CA 95814

Post-It® Fax Note	7671	Date	9/11/00	# of pages	1/4
To	Ed Danner	From	B. CURRIER		
Co./Dept.		Co.			
Phone #		Phone #			
Fax #	858 278 5300	Fax #	916 653 6366		

SUBJECT: BMP Operation, Maintenance and Monitoring Plan (Plan) – CDS Units

Dear Brian,

I am writing to comment on and suggest changes to the September 1999 subject Plan. The Plan is thorough and contains all the elements of a comprehensive sampling program; however, I am concerned that the Plan as developed will not result in an objective evaluation of the storm water pollutant removal capabilities of the CDS Technology.

The CDS system is designed to remove gross pollutants including trash and debris and sediments and the attached pollutants including metals, nutrients and oil and grease. The system is also capable of removing free-floating oil and grease when sorbents are applied in the separation chamber. It is not designed to remove dissolved pollutants and bacteria. The efficiency of the unit to remove fine sediments and the pollutants attached to those fine sediments is dependent on the size of particles in the runoff.

The Plan would propose to use automatic samplers to collect influent and effluent samples to determine EMCs. Section 1.4.3 indicates that the efficiency of the CDS unit will be determined through a statistical analysis of this data. In addition the floatables and material collected in the sump basket will be characterized.

Various studies have shown that automatic samplers have limitations in the capture of solids in storm water runoff including particles larger than 100-125 micron. This is extremely important to the successful evaluation of the CDS system because many studies have shown that 80-90% of the particles deposited on highways are larger than this size range. In addition the physical characteristics of the tubing used by automatic samplers and the protective strainers preclude collection of gross pollutants.

CDS has developed a Mass Balance Approach to overcome these limitations that provides for accurately determining the volume and characteristics of the material collected in the sump over a fixed period of time to determine the mass of pollutants collected. The efficiency of the system is then determined by measuring the effluent volume and characteristics discharged or bypassed by the CDS unit to determine the mass of pollutants discharged over the same period of time. Attached is a diagram that helps explain the approach. The efficiency is then calculated by dividing the pollutant mass discharged/bypassed by the sum of that mass and the mass of the pollutant captured in the sump. This approach is very similar to that used by the USGS in the study conducted of the Stormceptor system in Madison, Wisconsin. That study confirmed that

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automatic samplers even in that setting had limitations to capture particles larger than 63 micron (upper range of coarse silt).

The Plan can be modified to use the Mass Balance Approach by a few changes to Section 5.9 Characterization of Collected Material. This Section also requires modification to make it consistent with CDS Technologies recommendations for the routine maintenance and cleanout of the sump. The following modifications are recommended:

1. Remove floatables as suggested, but transport to laboratory for characterization rather than hanging on a fence to drip-dry in a mesh bag. That process seems to have little quality control over the management and potential for alteration of the sample particularly in the event of rainfall or loss of chain of custody.
2. The volume of material captured in the sump should accurately measured and representative samples obtained for analysis. This can be achieved by taking the sump contents to the laboratory; however, use of a Phase Separator in the field would provide a better alternative if the sump contents are greater than a few cubic feet.
3. Defined sampling periods need to be established so that the period of monitoring the influent and effluent correspond to the cleaning or removal of captured material from the CDS unit. The original guidance provided by CDS specified the cleaning frequency at four times per year. Based on recent experience we now recommend that the units be cleaned after the first 5 inches of rainfall during the season or when the material is 85% of the sump capacity and at the end of rainy season.
4. The volume and characteristics of the pore water remaining in the sump and separation chamber should be determined to allow completion of the Mass Balance Approach analysis.

The overall efficiency of the CDS system would require reporting of floatables captured and mass balance analysis rather than the comparison of influent and effluent results collected by automatic samplers. The TPH removal efficiencies would be determined from the grab samples of the influent and effluent.

It appears that some cost savings could be realized by eliminating the dissolved metals and fecal coliform analysis since CDS does not claim to remove those analytes. It would also be useful to have the particle size of the material captured by the sump analyzed.

We are available to further discuss the Plan and provide comments on the procedures that can be used for sampling and characterization of the material captured in the sump. Please call me at 1-888-535-7559 if you have any questions about this letter.

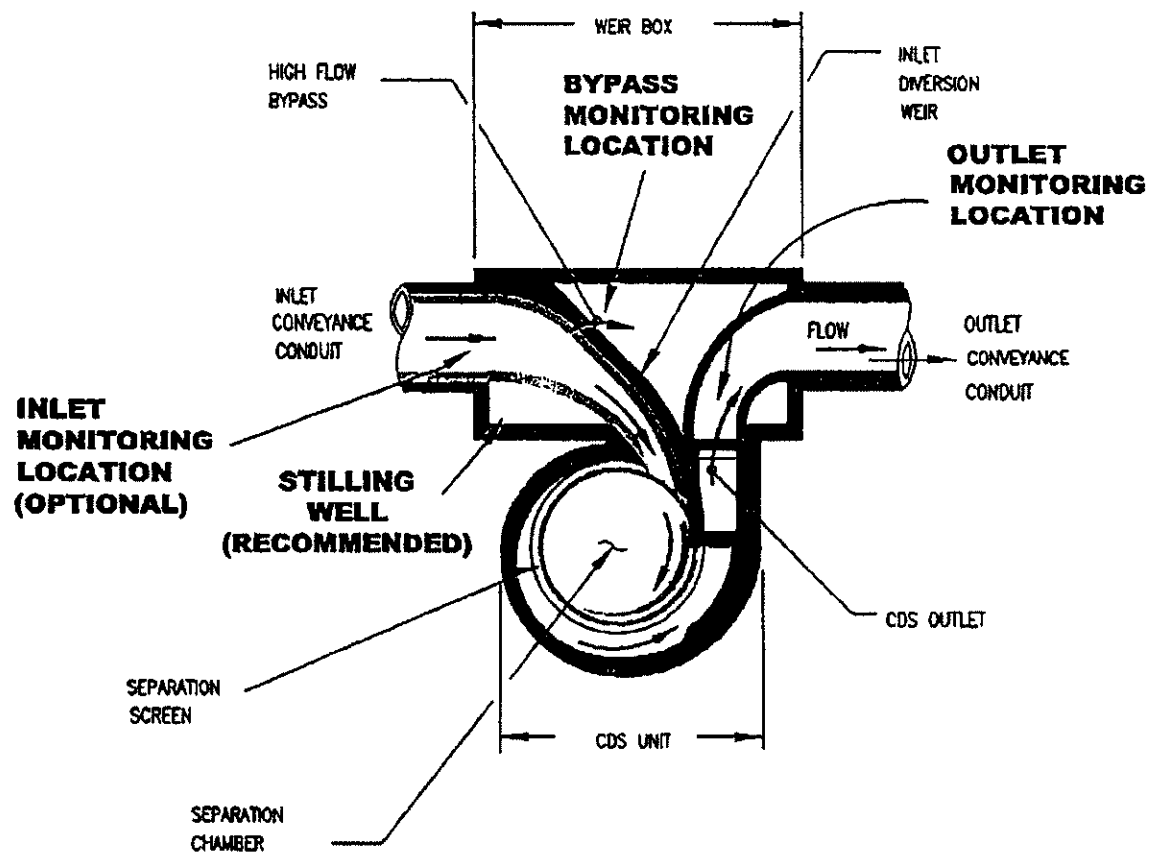
Sincerely,



Robert Howard  
Manager US Operations

Co/ Edward F. Othmer, Law  
Scott Taylor, Robert Bein, William Frost & Associates

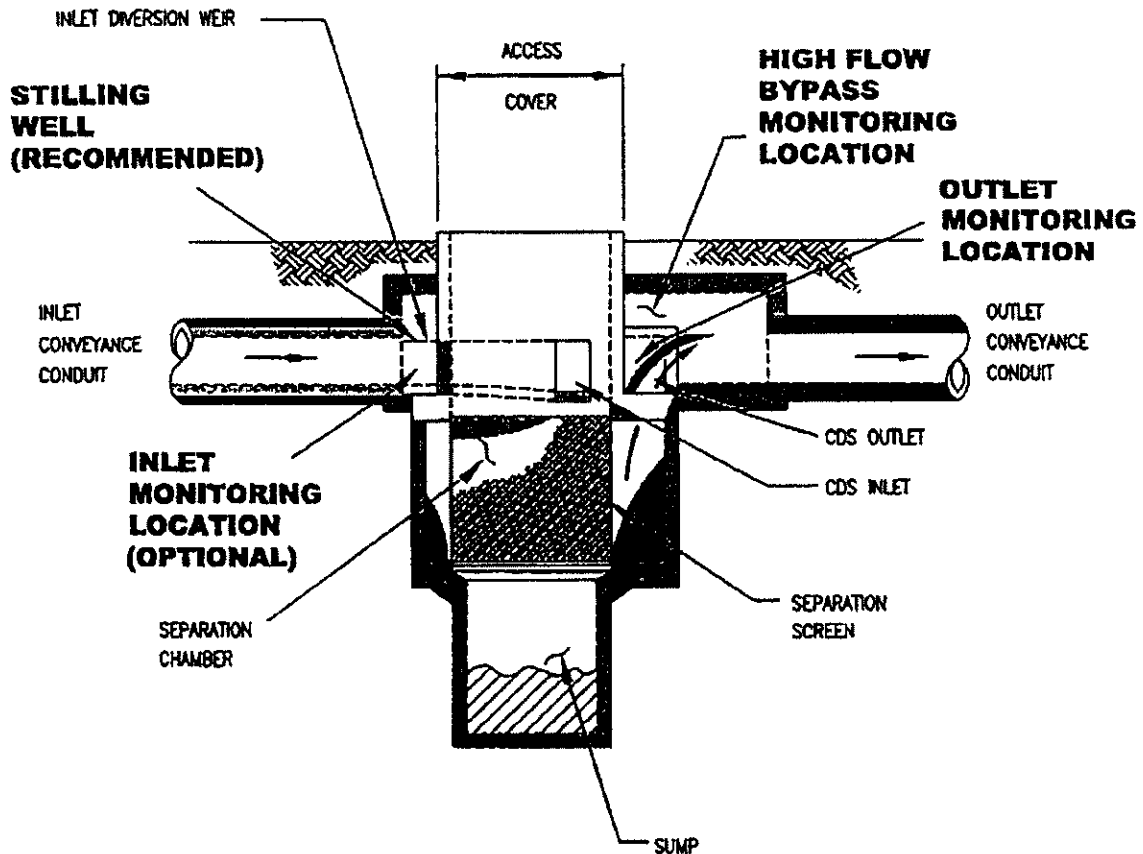
# CDS EVALUATION PROTOCOLS - MONITORING LOCATIONS



PLAN VIEW



# CDS EVALUATION PROTOCOLS - MONITORING LOCATIONS



## EFFICIENCY DETERMINATION

$$\text{EFFICIENCY} = \frac{\text{SUMP LOAD} + \text{SEPARATION CHAMBER LOAD}}{\text{OUTLET LOADS} + \text{SUMP LOAD} + \text{SEPARATION CHAMBER LOAD} + \text{BYPASS LOADS}}$$

$$\text{SUMP LOAD} = \text{DRY WEIGHT SOLIDS} \times \text{POLLUTANT CONCENTRATION}$$

$$\text{SEPARATION CHAMBER} = \text{CHAMBER MASS} \times \text{POLLUTANT CONCENTRATION}$$

$$\text{OUTLET LOADS} = \sum \text{INDIVIDUAL STORM EVENT LOADS (MASS} \times \text{EMC)}$$

$$\text{BYPASS LOADS} = \sum \text{INDIVIDUAL STORM EVENT BYPASS LOADS (MASS} \times \text{EMC)}$$

$$\text{BYPASS LOADS} = \sum \text{INDIVIDUAL STORM EVENT BYPASS LOADS (MASS} \times \text{EMC)}$$

ELEVATION

